CURRENT ANTI-AGEING RESEARCH AND ITS POTENTIAL IMPLICATIONS FOR AGEISM

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ABSTRACT

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Although still in its infancy, anti-ageing research has both breadth and depth. Currently, hundreds of researchers are interested in delaying the ageing process and extending lifespan, and there are already several theories of how it could be accomplished. Metformin, telomeres, Rapamycin, the GH pathway, stem cells, and nutrition are all related to ageing and could be manipulated in order to help significantly extend the lifespan. The first part of this thesis is dedicated to summarizing current anti-ageing research.

Ageism is discrimination or prejudice against someone based on their age. Although not as widely discussed as racism or sexism, it is just as common and can have many damaging effects. Older people see discrimination in the workplace, poorer treatment in healthcare, and a general low status in society due to ageism. The causes of ageism are complex. Studies indicate that fear of old age and death, common stereotypes, and lack of visibility for older people all contribute to ageist behaviors. The second part of this thesis is dedicated to investigating the causes and effects of ageism.

Anti-ageing research could potentially lead to an extended lifespan, which would impact many areas of life. For instance, an extended lifespan would likely change how age is viewed in society, impacting ageism. The final part of this thesis is dedicated to exploring ideas of how an extended lifespan would alter ageism.

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INTRODUCTION

Although it is inevitable, humans have a universal fear of death. In stories, heroes and villains alike work to evade death's grasp, but in the end, all mortals succumb to it. Although in stories authors have the power to make their characters defeat death through immortality, people have no such power in real life. Yet, growing technological capabilities have made it easier to target specific ways to increase lifespan. Internationally, researchers are devoting their lives to finding a way to "defeat" the aging process. This research does not look like what people have read in storybooks. There is no magic elixir or spell that would defeat death. Ageing is a complicated, multifaceted process, and there is likely no defeating it completely. Rather, anti-ageing research looks to target specific causes of aging and find a way to prevent or postpone these processes. Perhaps this practice could be done though gene therapy or by taking a pill. Research is still in early development, but people are learning new things every day. It is conceivable that within the next century, humans could find a way to significantly increase their lifespan. To some people, ageing is the main threat that we face as people. In a way, this idea is right. Death is the one commonality among all people. No matter where we come from, no matter what our problems are, it is the one unavoidable aspect of life. Yet, many others would argue that death is not our biggest threat specifically because it is unavoidable. They would prefer to focus on problems that we face while living. For instance, people might say economic issues, environmental problems, or social rights causes are humanities biggest threats. It is important to recognize that anti-ageing research is happening, and extending human life is a potential reality. The extension of human's lifespan would without a doubt significantly impact the economy, the environment, and social rights as the global population would rapidly change.

In this paper, I will give an overview of anti-ageing research and discuss how an increased lifespan could impact ageism.

In order to understand anti-ageing research, there must first be a basic understanding of how ageing works. It is not as simple as it appears. There are several "theories of ageing," although it is unlikely that any single theory would be the sole explanation. More likely, there is some truth in many of the theories. One of the oldest theories of aging is the "wear and tear" theory. Essentially, it states that over time, our bodies accumulate damage that it cannot repair. Eventually, this damage prevents our bodies from properly functioning, leading to age-related diseases and disorders. Some people refute this theory as our bodies have shown a decent ability to recover from damage. Broken bones mend, wounds heal, and DNA repairs itself. Yet, there are parts of our body that rarely recover. For instance, nerve damage is difficult to repair. It is also possible that our ability to repair declines with age. Yet, the wear and tear theory does not explain why that might be. Another prominent theory is that oxidative stress and free radicals damage the body, causing it to age. Research has shown that aged mammals have higher quantities of these oxidative agents in their bodies. Although this simple correlation cannot lead to a definite link between these agents and ageing, it is known that free radicals and reactive oxygen species cause damage to tissues. Generally, this damage leads to a lower energy production and increased signs of ageing. While tissue damage leads to ageing, DNA damage can be an even greater underlying cause. The telomere shortening theory explains some of how DNA can become more damaged with age. Telomeres are the end sections of DNA, and their role is to protect the bulk of DNA from degradation. Each time that DNA replicates, telomeres shorten in length as the cell is unable to copy the very ends of DNA. Therefore, as people age, their telomeres shorten. Once again, it is impossible to say that because telomeres are shorter in

older populations that short telomeres cause aging. However, research has shown that short telomeres are linked to irreversible cell cycle arrest known as cellular senescence. There are several other theories of ageing, yet the ones discussed above are more relevant to discussion of current anti-ageing research.

It is also important to note that anti-ageing research does not simply focus on increasing lifespan. Researchers looking to extend life do not want a world in which there is a drastically increased population of elderly people that cannot care for themselves. Rather, it is important for them to increase healthspan along with lifespan. If lifespan increased without healthspan, people would be living longer, but not be living healthier. They would have more problems as they age such as cancer, heart conditions, bone problems, and memory issues. Perhaps these issues would be manageable so that lifespan could increase, but they would be draining on the economy, the healthcare system, and for individuals themselves as they face such issues. Yet, increasing healthspan would prevent many of these problems. Although it is unlikely that these problems can be completely prevented, the ideal would be for them to be postponed with the increase in lifespan so that people can still take care of themselves without significantly relying on others and putting a burden on the healthcare system. In this paper, increasing lifespan and increasing healthspan go hand in hand. It can be assumed that when an increase in lifespan is mentioned, it includes an increase in healthspan unless otherwise mentioned.

Two hundred years ago, people in the United States lived to be about 38 years-old. However, if they reached the age of five, life expectancy increased to about 55 years. One hundred years ago, life expectancy increased to about 62 years-old given that people were able to make it to the age of five. Now, live expectancy at birth is nearly 80 years-old. This great increase in life expectancy is due to sanitation efforts and increased medical capabilities.

Increased life expectancy has led to a substantial growth in the elderly population. Currently, people over the age of 65 make up about 15% of the population, and this number is continuously increasing. Trends show that the elderly population could make up about 21.7% of the population within the next two decades. This growth in the elderly population has had a significant impact on the economy and cultural values. One of the greatest changes in society over the past century has been the rise of ageism, or the discrimination and prejudice against a person based on his or her age. The success of anti-ageing research would lead to another, likely even greater boom in the elderly population. Society would need to shift many priorities, making room in the economy for the impact of people working for more years than ever before. This huge shift in society would likely also impact people's views of the elderly, as it has done in the past.

For the first section, I will review several current anti-aging techniques, analyze their progress, and hypothesize a potential reasonable age increase based on the research. I will likely include both experimental articles and review articles, but I will not be generating my own data. I will provide extensive summaries of the research involving the shortening of telomeres and the use of metformin to extend life. These topics are extremely popular in the conversation of extending life, so they deserve a little more attention. I will also discuss other efforts to extend life in a slightly less detailed way. These efforts include the use of rapamycin, potential alterations in the GH pathway, stem cell research, and nutritional changes.

In the second part of the paper, I will discuss the rise of ageism, its impacts on the elderly, and its causes. Ageism can technically impact people of any age, but much of the current research has focused on ageist views towards older populations. This paper will also focus on ageism towards older populations as it has a greater association with anti-ageing research.

Various primary and secondary texts are likely to be analyzed in order to discuss ageism in its current state and how it came to be. Much of the focus will be on ageism in the United States, yet research from other countries might also be used as the information is still applicable.

In the final section, I will make a prediction of how ageism could change based on previous trends if the research discussed in the first section of the paper becomes both successful and prevalent. Several assumptions are going to be made to make this prediction, including that the anti-aging techniques are widely available and that there is a limit to their capabilities. For example, everyone in the population must have access to a medication that helps extend the life expectancy by 50 years. The final part of the paper will be an analysis of changing trends in culture, and, specifically, how ageism could change assuming that people live significantly longer. Perhaps anti-ageing research could decrease the factors that make ageism a problem in society. For instance, it is possible that extending life could decrease fear of death and economic burden. However, it is also possible that these factors will simply shift to an older age group. Perhaps anti-ageing research could be viewed as a form of ageism itself. The final section of the paper will essentially be a conversation given the information provided in the previous sections about the relationship between ageism and aging.

The purpose of this paper is not to question whether or not anti-ageing research is ethical. There is no question that the research is happening. Therefore, it seems that the more important question is not whether or not we should do it, but what will be the impact if it is successful. If people are able to extend life by a significant amount, then there will be impact on the economy, education, food supply, culture, and more. Hopefully, by looking into anti-ageing research, we can have a better understanding of its potential.

PART I: CURRENT ANTIAGEING RESEARCH

TELOMERES

Telomere control is a widely-known strategy to combat the aging process. Telomeres are bits of noncoding DNA at the end of our chromosomes. During replication, the ends of the chromosomes shorten slightly due to inability to copy the ends (Are Telomeres the Key to Aging and Cancer, n.d.). Telomeres protect regions of DNA important for bodily function, including coding regions and regulating regions. Therefore, during division, as much as 300 base pairs of telomere DNA is lost. Once cells lose too much of their telomeres, they lose the ability to divide, and they die. The length of telomeres in various age groups shows how they can shrink over time – newborns have telomeres of approximately 8,000 base pairs, adults have telomeres 3,000 base pairs long, and the telomeres of elderly people are approximately 1,500 base pairs long. Cells have an enzyme called telomerase that can maintain telomere size. However, continuous division decreases the amount of telomerase, making telomeres shorten faster. Cancer cells are able to continuously divide by putting off other functions in favor of making more telomerase. Inhibiting telomerase is one way that cancer could potentially be treated. That treatment option might be risky as it could impact the telomerase of otherwise healthy cells and prevent wound-healing, fertility, and the production of blood cells, processes which require an abundance of cell division. One of the most important aspects of telomeres is its association with aging. Relatively shorter telomeres are strongly correlated with shorter lifespans due to conditions like heart disease and illnesses from infectious diseases. This fact means that among elderly individuals, the people with shorter telomeres are more likely to die from these disorders. It is unknown how much telomere length contributes to aging, but it is an important topic in an exciting field that

many people have attempted to study. If people can control telomere length, can they save important cells from dying off, making it so that people can live longer and healthier lives? People have attempted to study telomeres in relation to cancer and more.

Although the idea of controlling telomere length is appealing, there is a question of logistics. There are different ideas and strategies of how to manage telomere length. One is more simple than others: lifestyle changes (Vidacek et al., 2018). There is potential to impact the length of telomeres through diet control, exercise, and limiting stress. Poor lifestyle choices such as lack of exercise, smoking, alcohol consumption, and processed meat consumption can lead to an increase in reactive oxygen species (ROS) which in turn damage DNA. Even more than lifestyle choices, dysfunctional mitochondria lead to the production of ROS. ROS in moderate amounts are beneficial, but excess ROS in cells lead to oxidative stress which creates oxidative damage. Although there is limited outside control of dysfunctional mitochondria, people can control lifestyle choices to limit ROS production. For instance, antioxidants can offset free radicals by donating electrons. Antioxidants are acquired by the body through the consumption of various vitamins and minerals such as Vitamins C, D, E, and folate as well as minerals like zinc and magnesium. There have been positive correlations between antioxidant consumption and telomere length. In addition, polyphenols, natural chemicals found in tea, have shown to positively influence telomere length. There are potential weaknesses in these studies as tea-drinkers tend to live healthier lifestyles. However, studies do show strong correlations. For instance, elderly Chinese people who drink tea regularly have been found to live on average five years longer than their peers with less tea consumption. Regulating fat consumption could also impact telomere length. Studies show that it is important to maintain a greater amount of omega-3 fatty acids relative to omega-6 fatty acids. Various diets also have the potential to impact

telomere length. The effects of caloric restriction have been studied in animals such as rhesus monkeys and mice. Studies have indicated that caloric restriction delays the onset of age-related disorders, although they are mixed as to whether it actually increases lifespan. More studies must be done in humans to understand the effect of the diet. The Mediterranean diet, one full of healthy fats, grains, fruits, vegetables and low fat meat and fish, has a positive effect on telomere length, possibly because it is rich in antioxidants. Finally, healthy lifestyle choices such as reduced alcohol consumption, keeping up with mental health, and being a nonsmoker also limit the aging process. These choices might be difficult for some to make and nearly impossible for others. However, they are important to learn about as healthy choices could have a direct, measurable impact on aging due to its influence on telomere length.

Telomere length has shown to be associated with several age-related disorders. For instance, studies have considered telomere length and its relation to Alzheimer's. The diagnosis of Alzheimer's disease is a terrible tragedy, as the forms of treatment are few and far between. One study conducted a meta-analysis observing the relationship between Alzheimer's and telomere length (Forero et al., 2016). The researchers looked at 13 studies which included a total of 860 Alzheimer's patients and 2,022 controls. The result was a significant relationship between telomere length and whether a person had Alzheimer's disease or not. The relationship was strong with a p value less than 0.001. However, it is important to note that the relationship could also be due to a confounding effect. Short telomeres are also associated with low amounts of exercise and higher amount of stress, factors also associated with Alzheimer's. More studies would be needed to confirm the relationship between telomere length and Alzheimer's disease. Still, people show confidence in the relationship as they are currently considering using short telomeres as a biomarker for disorders such as Alzheimer's. In this way, people with relatively

short telomeres could be identified so that their health could be more closely monitored. Perhaps in the future, technology will develop that will allow a potential treatment for Alzheimer's to be a maintenance of telomeres. However, one would first have to establish that there is a causal relationship between the length of the telomeres and Alzheimer's. As telomeres are so crucial to the activity of nearly every cell, it is not out of the question that there would be some kind of relationship. In fact, there is already evidence that telomeres play a "role in the response and plasticity of postmitotic neurons to oxidative and genomic stress" (Forero et al., 2016, pg 1069).

Large amounts of studies have focused on the relationship between telomeres and cancer. Cancer cells are essentially focused only on dividing constantly. They do not accomplish their normal cell functions. This behavior is what makes people so sick. As previously discussed, when cells divide, their telomeres shorten. Eventually, they get to a point where they can no longer divide. Telomerases exist to help maintain telomere length. In normal cells, telomerases run out. Cancer cells, however, focus a significant amount of their energy on making telomerase so that they can continuously divide. Normally, cancer cells are able to accomplish this action by activating or increasing the translation rate of the *hTERT* gene that encodes telomerase (Jafri, Ansari, Alqahtani, & Shay, 2016). The activation of this gene is not completely understood, but a couple of pathways are thought to be due to specific point mutations in the promoter of the gene that leads to upregulation. As mutated telomerase activity is present in 90% of cancers, it is an ideal target for anticancer therapy. The ultimate goal would be to inhibit telomerase activity without severely risking healthy body cells' ability to divide. This process is aided by the fact that cancer cells have a much higher use of telomerase than normal cells, so they are more likely to be impacted. In addition, telomeres in cancer cells are shorter than they are in healthy cells, so that reduced telomerase activity would impact them faster. Once the cancer cells have been

killed, the treatment could be stopped. There are several known telomerase inhibitors, and they are either on their way to clinical trials or already there. The drug most studied in clinical trials is imetelstat, a competitive inhibitor of telomerase. Imetelstat is currently in phase II of clinical trials, making it several years away from being available to the general public if approved.

Ironically, while limiting telomerase could be helpful in treating cancers, increasing the use of telomerase has the potential to limit the shortening of telomeres, possibly reducing the significance of various disorders such as Alzheimer's disease and mental health disorders. In order for telomeres to be controlled, there would have to be specific limits to the amount of telomerase prompted in order to control the risk for cancer. There does not seem to be any current research making significant headway into this idea. In fact, it is possible that telomere length is a side effect of aging rather than a part of the cause. Still, telomere length and its relation to aging has been discussed strongly as something to look into in the future. Indeed, perhaps there is potential for being able to maintain the length of telomeres without the use of high levels of telomerases, which would increase the risk of cancer.

METFORMIN

Metformin is a synthetic derivative of galegine, a product of the plant *Galega officinalis* that was found to be too toxic to work as a drug itself (Rena, Hardie, & Pearson, 2017). Because metformin is not a purely synthetic drug, but rather mostly derived from natural sources, its mechanistic actions have been widely debated. The majority of the drug is absorbed into the small intestine when ingested, and the rest passes through the body and gets excreted without significant interaction. From the small intestine, metformin is transported to various organs where it does the majority of its work. The mechanisms are not clear, but there is consensus that

the drug interacts with the liver in order to lower glucose production. In addition, it influences the gut to use more glucose. Together, these actions decrease the amount of glucose in the body. These actions have the potential to impact a variety of diseases and disorders, and this statement has proven to be true when considering the history of metformin.

Metformin was first used medically in the 1920s in order to treat diabetes due to its ability to lower blood sugar content (Bailey, 2017). However, it was discontinued due the discovery of insulin. It began to be used again in the 1940s and 1950s in order to treat malaria and the flu. Yet, it was not as effective in treating these illnesses as other drugs, making its use limited. After extensive research, metformin reemerged in the public as the primary drug to treat hyperglycemia in individuals with adult-onset diabetes, or type 2 diabetes. Although metformin is generally intended to be used as a diabetes drug, a niche group of health-conscious individuals have begun to take it regularly in an effort to increase their life-span. These ideas are being taken seriously, as significant research has been done in an effort to see how metformin could affect the body in otherwise healthy individuals. The discovery of metformin's effect on aging-processes was somewhat accidental. It has been shown to postpone the onset of inflammation and various cancers, age-related conditions. Additionally, animal studies have indicated the potential of metformin's ability to specifically increase lifespan.

Inflammation is related to several disorders that tend to increase in severity with age. Decreasing inflammation could alleviate these disorders, making management of inflammation an important concept to consider when trying to expand lifespan. Metformin potentially interacts with several molecules that could lead to the reduction of inflammation (Saisho, 2015). For instance, metformin has been shown to inhibit the activity of nuclear factor κB (NFκB), leading to the activation of 5' AMP-activated protein kinase (AMPK.) AMPK then regulates

inflammation. The exact pathway in which these interactions occur is debated. Metformin also inhibits the formation of advanced glycation endproducts (AGEs). AGEs are one of the molecular products responsible for inflammation. The mechanism for the prevention of AGEs is slightly more understood. Essentially, metformin interacts with precursors of AGEs, preventing their formation. The majority of inflammation studies have considered metformin's impact in vascular endothelial cells, which would impact cardiovascular health. However, some studies have shown similar results in other cell types. metformin has been used in clinical studies to observe effects in patients with type 2 diabetes. Inflammation control was often observed in these studies. The studies have suggested that combination therapy might be more effective at controlling inflammation than metformin alone as metformin combined with exenatide was shown to be effective. In addition, when lifestyle changes were implemented, the results were far more significant. However, metformin still showed promising results alone. As the studies were done in patients with type 2 diabetes and impaired glucose tolerance, it is unclear as to whether it would have the same effect in otherwise healthy individuals.

Although cancer is a disease that can happen at any moment in a person's life, trends show that the majority of cancers happen as we age. Our cells are more likely to make mistakes and less likely to kill off cells that lead to cancer. Although there are some cancers that are more prominent earlier in life, the majority occur later. Metformin has been implicated with the ability to both prevent and treat cancer (Morales & Morris, 2015). As metformin interacts with several biological materials in the body, there are many pathways in which metformin impacts the progression of cancer, although they usually include inhibiting growth stimuli and metabolic processes. Because metformin reduces blood glucose, it reduces the need for insulin and lowers insulin levels. As insulin might be used as a growth factor for cancer cells, the use of metformin

could potentially inhibit their growth. Similar effects have been shown in caloric restriction models which also serve to lower insulin levels. There is also potential for metformin to make an impact that is not related to glucose. Activation of the previously discussed AMPK could also lead to a decrease in aerobic glycolysis, a main form of energy creation for cancer cells. If cells lack a functioning AMPK pathway, metformin could induce apoptosis through decreased ATP. Essentially, if the cell does not have enough energy, it will die. Activation of AMPK also decreases inflammation as previously discussed. Chronic inflammation has been shown to play a role in promoting cancer growth. The reduction of inflammation due to the actions of metformin will therefore reduce the risk of cancer. Clinical studies of type 2 diabetes patients indicate that the use of metformin has significantly reduced cancer mortality. Some of the cancer types that metformin has shown to influence are breast cancer, liver cancer, and ovarian cancer. Although these are the most implicated cancers, other cancers have been implicated as well. However, different studies have shown different levels of success. In addition, model animal studies and clinical trials at times indicate different findings. More studies are needed, specifically more studies with humans, in order to have more concrete findings on the impact of metformin on cancer. Yet, the current findings are promising.

Metformin has been shown to influence several possible disorders associated with aging. Yet, how does that translate to actual life expectancy? In animal studies, metformin has shown promise (Novelle, Ali, Diegues, Bernier, & Cabo, 2016). For instance, *Caenorhabditis elegans*, or *C. elegans* were given a small dose of metformin (50 mM doses), leading to an extension of lifespan by 40%. The effects of metformin mimicked the effects of caloric restriction. The lack of glucose induced mitohormesis which led to a decrease in oxidative stress. When similar studies were done in *Drosophila*, lifespan did not significantly increase. However, metformin

was shown to reduce DNA damage by limiting oxidative stress. The mechanisms of this impact were not understood in the study. Conflicting evidence was found in different mice models, likely depending on the strain of rodent used as well as the dose and length of metformin given. In one study, metformin significantly increased the lifespan of female mice prone to cancer. However, males were not significantly impacted. Another study showed an even greater increase in life expectancy independent of metformin's influence on cancer as it was not shown to influence tumor growth, a somewhat unexpected finding. The age of the mice in the metformin studies also influenced its effectiveness. Generally, metformin was more effective at extending lifespan when given to the mice earlier in their life. However, there were some effects even in elderly mice. Ultimately, metformin remains a good candidate for aging research. Yet, there is great range as to how the drug could be presented. The drug impacts bodies differently in different doses, given at different times, and at different points in life. In addition, there is no guarantee that how the drug acts in animal models would translate to how it works in humans. Metformin could be more beneficial, or less beneficial. It can already be seen that metformin influences different species differently, as it was more effective in certain strains of mice as well as more effective in *C. elegans* than *Drosophila.*

The interactions with the human body and metformin are incredibly complex and require significantly more research. Most of the human studies involved with metformin have been focused on its impact on diabetes. Therefore, it is difficult to tell how the drug would impact otherwise healthy individuals in an effort to prevent future problems. However, researchers are hopeful that they can begin clinical trials with metformin that focus on aging. Although some of the research has shown mixed results, the drug is still exciting to many specifically interested in aging studies. In fact, a group of gerontologists has been given a grant in order to study using the

drug in humans to prevent aging (Barzilai, Kritchevsky, & Espeland, 2016). The study will be called "Targeting Aging With Metformin" (TAME). The plan for the study is to enroll approximately 3,000 elderly subjects and to observe the effects of metformin compared to a control group. The study will monitor the onset of age-related disorders such as cardiovascular disorders, cancer, dementia, and mortality. Yet, in order to fully understand the effects of metformin, more studies such as these will need to be done. Studies must focus on the variable effects due to age, sex, health conditions, and more. For more studies to be done, the risks of using metformin must also be considered.

While metformin is generally considered a low-risk drug, there are still potential risk factors that could keep people from wanting to take it regularly in an effort to extend life. For instance, metformin increases the risk of lactic acidosis by increasing plasma lactate levels (Defronzo, Fleming, Chen, & Bicsek, 2015). Although lactic acidosis is rare, it has a mortality rate of 50%. Currently, potential patients with moderate to severe renal impairment are not allowed to use metformin as a poorly functioning liver will make lactic acidosis more likely. It is conditions such as lactic acidosis that could keep clinical metformin trials focused on aging from occurring, even if metformin is otherwise regarded as a safe drug. Aging is not currently considered a serious disease or disorder, but rather a natural part of life. There is potential in the future for the view of aging to change, and this change could allow more studies to take place. Although a few individuals have begun to take metformin regularly, it is likely that the general population is far from gaining regular access to metformin as a life-extending drug.

RAPAMYCIN

Another potential life-extending drug is rapamycin, which is produced by a certain species of bacteria. Currently, rapamycin is used as an immunosuppressant to prevent organ transplant rejections (Bitto et al., 2016). The drug works by inhibiting mTOR, a kinase important in RNA translation as well as cellular growth and metabolism, leading to a variety of effects. One of these effects is slower cellular growth. Despite its immunosuppressant effects, various studies show that rapamycin has extended the lifespan of yeast, nematodes, fruit flies, and mice. In mice in particular, the drug has been shown to postpone the onset of age-related disorders. Researchers are unsure of exactly how rapamycin is extending life. It is possible that the drug could be slowing the process of aging itself (Wilkinson et al., 2012). It is also possible that the drug is delaying the onset of cancer growth. The drug could even be doing both of these things at once. Because rapamycin has a variety of effects, it is important for researchers to study the impact of rapamycin at various doses. When used for organ transplants, the higher dose of rapamycin can cause high cholesterol levels, mouth ulcers, and reduced healing capabilities (Bitto et al., 2016). Therefore, a lower dose of rapamycin would need to be used to extend life. One study considered how it would be difficult to regularly provide people rapamycin to take at small doses throughout their lifetime (Bitto et al., 2016). They decided to conduct a study in which they gave middle aged-mice three months of rapamycin treatment in an effort to see if rapamycin given at this point in an organism's life would be successful at extending life. Mice were given either a high dose of rapamycin or a low dose of rapamycin. Mice given the low dose of rapamycin lived approximately 50% longer than untreated mice. Male mice given the high dose lived about 60% longer than untreated mice. When female mice were given the high dose, however, they had an increased risk of forming rare blood cancers. This study highlights the

importance of studying the drug in multiple settings. Different doses given at different times of life could have different impacts. Additionally, differences in gender could affect the symptoms caused by the drug. More studies considering variabilities such as these are needed to push the legitimacy of rapamycin as a life-extending drug forward.

LARON SYNDROME AND THE GH PATHWAY

A rare form of dwarfism caused by Laron syndrome has shed light on a possible way to extend life. Laron syndrome is caused by a mutation in the *growth hormone receptor* (*GH-R*) gene. People with Laron syndrome have growth hormones, but their bodies do not respond to them properly. The appearance of Laron syndrome patients is similar to other dwarfs, but they have a particular symptom that makes them stand out – they appear to be resistant to disorders such as cancer and diabetes. A third of the world's population with Laron syndrome lives in a community in Ecuador. The condition has been spread throughout the community over many years due to the small population size and limited mating options, leading to some inbreeding. A study spanning 22 years observed 99 Ecuadorians with Laron syndrome (Guevara-Aguirre et al., 2011). During the study, only one subject was diagnosed with cancer, and no subjects were diagnosed with diabetes, despite a good portion of the Laron syndrome population being obese. The rates of cancer, diabetes, and obesity of the subjects were compared to their relatives unaffected by Laron syndrome. The relatives without Laron syndrome had a 17% chance of getting cancer, 5% chance of getting diabetes, and 13% chance of being obese. In comparison, only one out of 99 Laron syndrome patients was diagnosed with cancer, none were found to be diabetic, and about 21% were found to be obese. Likely, the obesity was due to patients with Laron syndrome being unconcerned with their diet due to being otherwise healthy individuals.

These findings have led others to study the impact of Laron syndrome in animal models. A study of mice with Laron syndrome found that the Laron syndrome mice live ten times longer than wildtype mice (Do Ecuadorian Dwarves Hold the Key to Curing Degenerative Diseases?). In addition, the Laron syndrome mice did not get cancer. In the Ecuadorian study, the subjects did not have a longer lifespan than their unaffected relatives. However, they were more likely to die from accidents rather than age-related diseases. There were 30 deaths of Laron syndrome patients during the study, and only 9 were due to age-related disease. Fifty percent of Laron syndrome subject deaths were due to either accidents, alcohol-related events, or convulsive disorders. Those categories made up only 3% of deaths in the relatives. It is possible that in different circumstances, Laron syndrome patients could have an extended life span. Due to the interesting results in studies such as these, researchers have been interested in the mechanisms behind this resistance to age-related disorders.

Laron syndrome leads to low growth hormone (GH) signaling as well as low insulin-like growth factor-1 (IGF-1). While the GH pathway is important for growth and metabolic function, it can also lead to oxidative stress and genomic instability. The GH pathway and similar pathways lead to an increase in DNA mutations by damaging DNA directly and indirectly through increasing superoxide production. Signaling in these pathways can increase cancer risks both by increasing DNA damage and by preventing apoptosis of damaged cells. In one study, mouse embryonic fibroblast (MEF) cells with IGF-1 signaling (R- cells) and MEF cells without IGF-1 signaling (R+ cells) were both exposed to oxidative damage (Guevara-Aguirre et al., 2011). The cellular damage was found to be greater in R+ cells. The researchers concluded that this result was likely due to the effects of FoxO. Normally, FoxO is responsible for promoting apoptosis and protecting against oxidative stress. However, FoxO levels were significantly lower

in R+ cells than R- cells, leading to less protection for the cell. Findings from as long ago as the 1970s support these newer studies (Bartke & Quainoo, 2018). For instance, Ames dwarf mice were found to have extended lifespan. The mice had a genetic condition affecting the anterior pituitary gland, which in turn led to a decrease in GH and IFG-1. Similar results were shown in Snell mice in a 2001 study. Snell dwarf mice have a mutation in the pituitary-specific factor 1 (*Pit1)* gene, leading to low levels of various hormones including GH, thyroid hormones, and prolactin. As the Ames and Snell mice have hypothyroidism and prolactin deficiency, it was impossible to confidently prove that the GH pathway was responsible for the longevity of the mice. However, researchers were eventually able to isolate the effects of deleting the GH receptor to provide evidence that it is the GH pathway specifically leading to the positive effects on lifespan. Similarly, homologous genes in *C. elegans* and yeast were found to be related to aging, indicating that the process has been conserved throughout millions of years of evolution. Overall, these studies indicate that significantly decreasing growth hormone signaling leads to an increased lifespan and healthspan, as various diseases are prevented and life expectancy increases. There is potential for humans to look into drugs that would decrease growth hormone after they have reached their full size.

STEM CELLS

Without stem cells, our lifespan would be significantly shorter. Stem cells are responsible for the rejuvenation of the body (Bell & Zant, 2004). They have the ability to replace a variety of cells that are lost due to an accumulation of damage. Stem cells have much longer lifespans than normal cells. Generally, they can last as long or even longer than the lifespan of the body. Stem cells too accumulate damage over time. It was once theorized that only a few stem cells were

activated at once, while the rest remained inactive, safe from potential exposure to oxidative damage. However, it seems that in actuality, all stem cells are active at once. Decline in stem cell function seems to correlate with aging, as it is more difficult to replace damaged somatic cells. Extending the life of stem cells or finding another source of stem cells could potentially increase lifespan as people would have a greater pool of cells to replace damaged body cells. For instance, research has shown that increased expression of *HOXB4*, *HOXA9*, and *PBX1* leads to enhanced renewal in stem cells that give rise to blood cells (hematopoietic stem cells). There is potential that the *Hox* genes could positively impact stem cells in other lines of cells as well. However, the overexpression of the *Hox* genes is also linked to stem cell cancer. While researchers attempt to extend the renewal capacity of stem cells, doing so could have the opposite of the desired effect if cancer is a potential outcome. Yet, there are other strategies for rejuvenating stem cells. In one study, the addition of NAD+ aided the rejuvenation of intestinal stem cells in mice (Igarashi et al., 2019). In the study, young and old mice were treated with NR, a precursor of NAD+. The addition of NAD+ did not significantly increase the number of intestinal stem cells in young mice. However, the addition of NAD+ brought the total level of intestinal stem cells in old mice up to the levels of intestinal stem cells in young mice. The increased number of stem cells also led to an increase in the functionality of the gut, as determined by its ability to replace cells damaged by dextran sulfate sodium. In a review of techniques for the rejuvenation of muscle stem cells, it was shown that potential strategies include inhibiting p16 and p38 MAPK, the addition of NAD+, and administering hormones such as oxytocin (Bengal, Perdiguero, Serrano, & Munoz-Canoves, 2017). Currently, these studies are limited to mice models. It will be interesting to see how the works translate to people. There are likely a variety of methods for

rejuvenation of stem cells, and they could all be different for the various lines. It is also possible that the addition of stem cells, rather than just the rejuvenation, could aid in preventing ageing.

For stem cells to continue being able to replenish somatic cells throughout the body, there needs to be a stable and healthy population. One way researchers have attempted to accomplish this is simply through injecting more stem cells into the body. There have been variable results, as it can be difficult for the new stem cells to be accepted into the new environment. For instance, one study attempted to insert hypothalamic neural stem cells from newborn mice into the mediobasal hypothalamic region through lentiviral induction (Zhang et al., 2017). This region was looked at specifically because the researchers previously hypothesized that it could have a causal relationship with aging throughout the body. Initially, the newly injected stem cells did not survive. The researchers then inserted the stem cells from newborn mice resistant to inflammation that might have caused the failure of the stem cells survival previously. A control group of mice was inserted with astrocytes. The mice injected with the inflammation-resistant stem cells lived significantly longer than the control mice, but only by about 80 days. Stem cells have the potential to impact a variety of areas of medicine due to their importance throughout the body. Ethical issues may keep researchers from learning more about the potential to use stem cells in a variety of ways, as the need for embryonic stem cells causes concern (Frequently asked questions about stem cell research, 2019). When it comes to aging, much of the focus is still on animal studies. However, to learn more about how stem cell therapy will impact people, numerous human studies will eventually need to be done.

NUTRITION

The anti-ageing strategies described in the studies above would take significant time and money for the general public to be able to access. Yet, substantial research has also been done on a strategy that people could start now in order to extend their lifespan – controlling nutrition. Of course, general healthy eating habits prevent diseases that lead to death. For instance, avoiding foods with trans and saturated fats is beneficial for preventing heart disease. Yet, there are other ways to control nutrition in order to slow ageing that might be surprising to the general public. For instance, one review article showed that nutrition during early development could have impacts on health throughout life (Duque-Guimarães & Ozanne, 2017). It discussed several studies that found that the babies that weighed the least at birth and when one-year-old faced more heart conditions, diabetes, and metabolic issues later in life, leading to a shorter lifespan. The Dutch Hunger Winter study was also discussed. In this study, it was found that people who were conceived during a famine were more likely to face glucose intolerance and heart disease than their siblings who were born during the same famine. These studies indicate that control of diet during development has implications for the person's life. So, how can a mother control her diet in order to give the best potential life for her baby? Researchers have studied protein restriction, iron restriction, and uterine ligation as ways to improve the health of fetuses. The studies had various results that indicated these strategies impacted rates of metabolic disorders. In an effort to determine if maternal protein restriction influences lifespan of the offspring, researchers fed pregnant mice a low protein diet either during pregnancy or during lactation and observed the lives of their offspring. They found that a low protein diet during pregnancy reduced the lifespan of the offspring. Yet, a low protein diet during lactation increased the lifespan of the offspring. It is unclear how diet is affecting the offspring to influence the lifespan,

but there is potential that nutrition during development causes epigenetic changes that last throughout the offspring's life. More research on nutritional intervention during development is likely to find information that would help the general public be able to provide their children a specific diet to benefit their overall health.

A person cannot control how they were fed as a fetus or as a child. Yet, there are other nutritional strategies that influence ageing that people can implement in their lives at an older age. Caloric restriction is one of the most highly studied nutritional strategies to combat the ageing process as it has fascinated researchers for decades. A multitude of studies has shown that caloric restriction has the potential to delay osteoporosis, sarcopenia, and brain atrophy (Balasubramanian, Howell, & Anderson, 2017). It also has to potential to prevent cardiovascular disease, arthritis, cancer, and age-related diabetes. All of these benefits work to extend lifespan. In fact, studies have shown that caloric restriction has extended life in mice, worms, yeast, nematodes, and fly models. Yet, success in animal studies does not always translate to success for humans. Studies on nonhuman primates can be more insightful, as they are people's closest ancestors and have biological mechanisms most similar to humans. A series of studies involving rhesus monkeys began in the 1980s, and the majority are still ongoing. In one of these studies, an adult-onset reduction in caloric intake by 25% resulted in decreased morbidity and mortality. Yet, in another study, there was not a significant trend. Comparisons between the designs of those two studies revealed information about how caloric restriction can benefit health. The major difference in the studies was the time in which caloric restriction was implemented. In the successful study, the monkeys had restricted diets while they were adults. In the study that failed to find significance, caloric restriction was implemented for different groups, juveniles and elderly. The juveniles that were fed a restricted diet did not show improvements in lifespan.

However, the old-age monkeys that were fed a restricted diet lived longer than expected. Within the study, a significant relationship between caloric restriction and lifespan was not found for the elderly monkeys with restricted diets. Yet, when the lifespans of those elderly monkeys were compared to the lifespans of rhesus monkeys in other similar environments, the relationship between caloric restriction and lifespan was significant. A likely reason for this result is that the control monkeys in the study also did not consume as much food. So even though they were the control group, they were experiencing some effects of caloric restriction. These studies could indicate that caloric restriction could have a very specific time period in which it would be beneficial for people. Likely, caloric restriction impacts several mechanisms throughout the body that would in turn impact lifespan and healthspan. For instance, caloric restriction has been shown to increase the activity of AMP-activated protein kinase, an enzyme whose activity decreases with age. More studies would be needed on humans to confirm the link between caloric restriction and increased lifespan. Ideally, discovery of how caloric restriction impacts the body could aid in the development of drugs that would mimic the effects of caloric restriction in an effort to increase lifespan.

CONCLUDING THOUGHTS

A common theme seen in the studies discussed above is that significantly more research is needed. Ageing is complex, and the forces driving it will require to be studied for decades in order to more completely understand them. Scientists have come up with several possible ways to delay ageing, sometimes accidently, as seen with metformin. It occurred somewhat recently that life expectancy increased considerably due to advancements in modern medicine, so continuing aging research is still in the beginning of its long journey. Scientists argue over just

how long they think that humans can extend their life. Some believe that the cap is around 115 years of life as this is about how long the oldest people in the world have lived (Park, 2017). Others argue that this decision is premature, as we have yet to explore many ideas around aging. Yet, as the global life expectancy is a little over 70 years-old, even an increase in life expectancy closer to 100 years-old would likely have significant impacts on many aspects of society. The breadth and depth of the studies about extending lifespan indicate that this hypothetical life expectancy is a genuine possibility. Therefore, the potential impacts of having an older society should be considered.

PART II: EFFECTS AND CAUSES OF AGEISM

In 1969, gerontologist and eventual Pulitzer Prize winner Robert Butler first introduced the concept of ageism as a significant issue in the United States (Levy & Macdonald, 2016). The problem of ageism has only grown in the past five decades as the elderly population has considerably increased. People over the age of 65 are the fastest growing population group, and they are projected to make up 22% of the world population by 2050. Despite being such a prominent group, the elderly face both prejudice and discrimination from younger populations, especially in western cultures. Ageism can range in its intensity. Butler distinguished two negative forms of ageism: one in which people were simply afraid of getting older, leading them to feel discomfort and anxiousness around the elderly, and one in which people felt as though the elderly should not have a significant place in society because they are essentially worthless. Ageism may not seem as pertinent in society as other social issues such as sexism and racism, but as recently as 2015, WHO argued that ageism might be more pervasive than those issues as it can impact the quality of care that the elderly receive (WHO, 2015). Ageism is seen in various parts of society such as in social roles, caregiving of the elderly, and the workplace.

STEREOTYPES AND SOCIAL EXCLUSION

In the past, elderly people in our society were revered as they held knowledge and wisdom. Yet, the role of elderly people in society has changed as perceptions of ageing and the elderly altered, and now, the overall views of elderly people in the United States tend to be mixed or negative. One study surveyed 154 people in California to find their views of elderly people and of ageing itself (Berger, 2017). The people that took the survey were between 18 and

72 years in age, but younger people made up the majority of the study. Findings were somewhat mixed as there are a variety of cultures within California, and even people within those cultures can vary in their opinions. However, there was an overall trend towards a negative association with older populations. Younger people in the study tended to have more negative feelings about the elderly people than older people in the study. Native Americans and Middle Easterners were more inclined to feel positive towards the elderly. It is likely that their cultures tend to be more respectful towards the elderly, giving them higher status. This study is limited as it did not survey a large group of people, and its focus was on one region in the United States. However, many similar studies find that people cling to stereotypes about older populations – both positive and negative. The elderly are often seen as warm and friendly, but also weak, needy, and incompetent. Together, these feelings combine to a sense of pity for the elderly. These stereotypes and perceptions play a role in the social exclusion of elderly people.

It is important for the health of people of all ages to maintain contact with people. As people reach a certain age, they are more likely to be socially excluded. Some of the causes behind this might be due to the diminished physical and mental abilities of the elderly. Some people might be too weak, forgetful, or unhealthy to enjoy plentiful social activities with others. Deaths of close friends and relatives, having few children if any, and singlehood can all also contribute to social exclusion. Perhaps these ideas act as a broad excuse when they only apply to a few elderly people. Social exclusion is not inevitable, and the general public can take some blame for the social exclusion of the elderly. One study utilized Strategic Frame Analysis to learn about people's perceptions of the elderly (Robbins, 2015). Twenty interviews were held in various cities across America. Through conversations with people about the elderly, the specific language they used was interpreted to reveal their genuine beliefs about older populations. One

of the beliefs was that older people were an "other" group in society. People did not connect the struggles of old people with themselves, and they were more likely to distance themselves from their inevitable future of ageing. The Fraboni Scale of Ageism supports the idea that people push older populations into social exclusion (Wethington, Pillemer, & Principi, 2016). According to the scale, there are three categories of ageism: antipathy towards the elderly due to beliefs in stereotypes, discrimination, and avoidance. Ageism that falls into any of these categories could lead to social exclusion. While the general public has a tendency to ignore the elderly in society, ageing experts view older adults as an important part of society, socially and economically, contrasting with the view of the general public (Robbins, 2015). The impact of social exclusion and social isolation partially caused by ageism can be detrimental to the health of the elderly population. Many elderly people face both loneliness and depression, difficulties only enhanced by their continued social exclusion. These problems can increase the risk of other hardships as well, as both depression and loneliness have been tied to negative effects on physical health and well-being (Wethington, Pillemer, & Principi, 2016). Ageism is not the only cause of social exclusion, loneliness, and depression in elderly populations, but it likely has a significant impact on the severity of those issues. Ageism has an even greater impact on other areas of people's lives, such as their role in the workplace.

IN THE WORKPLACE

Before ageism was officially defined, President Lyndon B. Johnson passed the Age Discrimination in Employment Act, indicating that a form of ageism has been taking place in the workplace for some time. The law was made to prevent people from not being hired or promoted specifically based on age. Employers would need to find other reasons to not employ an older

individual. Initially, the law only protected people from the age of 40 to 65, but eventually, the age cap was lifted. Now, the law protects everyone. Only jobs that require specific physical health are exempt from the law, such as fire fighters, police officers, and air traffic controllers. The Equal Employment Opportunity Commission (EEOC) is responsible for enacting this law. They receive complaints from people who believe that the law is being broken. Thousands of complaints are received every year. For instance, in 2019, 15,573 charges were filed with the EEOC (Enforcement and Litigation Statistics, 2019). For reference, 23,976 race-based charges, 23,532 sex based charges, and 2,725 religion-based charges were filed. Therefore, age discrimination is not quite as big of an issue as sex and race discrimination, but it is still significant. Considering that people above the age of 65 years-old make up about 6% of the workforce, and people between the ages of 55 and 64 years-old make up about 16.8% of the workforce, the amount of complaints is very significant (Lipnic, 2018). It is also likely that many instances of discrimination go unreported. Despite laws for protection, negative misconceptions of older populations can prevent them from being treated fairly in the workplace. Older people are seen as "inflexible, unwilling to adapt to technology, lacking an aggressive spirit, resistant to new ways, having some physical limitations, costing more for health insurance, and complacent" (Dennis & Thomas, 2007). Although there are some positive stereotypes, negative stereotypes seem to be more important when making hiring decisions. In one 1999 study, two fake applications were sent to 102 entry-level positions. The applications were equally qualified, but one was listed as 32 years-old and the was listed as 57 years-old. The older applicant received shorter interviews, fewer job offers, fewer call-backs, and fewer commissions. Studies show that this same kind of discrimination is common for promotions, training, and compensation as well

as hiring. Despite the law in place meant to protect these occurrences from happening, they are likely a common reality.

The age of retirement in the United States is 65 years-old, but as people are living longer, they are needing to work past that age. Additionally, as older populations are becoming a greater percentage of the population as a whole, there is a greater need for them to be able to support themselves through work rather than relying on family members. While stereotypes suggest otherwise, older populations are often healthy enough to work past the traditional retirement age. Yet, as ageism in the workplace still persists, getting a job, raise, or promotion can be difficult. Another, perhaps overlooked, side effect of ageism in the workplace is the impact that negative attitudes and treatment have on older workers' job satisfaction, commitment, and engagement. One extensive study surveyed employees at a small university, a manufacturing company, a division of a motoring organization, and two freight terminals to find relationships between age, psychological wellbeing, and job satisfaction (Taylor, Mcloughlin, Meyer, & Brooke, 2013). The survey was well advertised and received responses from about 40% of all of the employees. As the surveys were given to people in different industries, the answers could vary based on people's job types and social class. For instance, an elderly professor might receive more respect in his field that an older person in a more physically demanding job. The study accounted for these kinds of relationships when they created their models. When comparing ages, the study split the employees into four groups: ages 20 to 34, ages 35 to 44, ages 45-54, and ages 55-71. The study detected how employees felt supported, their psychological wellbeing, if they felt their work was meaningful, and their insecurity in the workplace. The two older groups were found to have lower psychological wellbeing than the younger groups. Perceived discrimination had the largest impact on job satisfaction for both the youngest and oldest groups. Perceived

discrimination was also the biggest predictor for psychological wellbeing for the oldest group. The more perceived discrimination, the worse off the psychological health of the older adults. Several studies such as the one described above has found similar results. Age discrimination in the workplace not only prevents older populations from fair treatment, it prevents them from being able to do their job to the best of their ability by draining their mental health and causing feelings of distance from their workplace. Reducing ageism in the workplace would create a more motivated and happier older workforce.

IN HEALTHCARE

Ageism impacts the way that older people are treated in many ways, but none are as important as the way they are treated in healthcare facilities. Healthcare professionals such as doctors and nurses can have dangerous biases against the elderly that lead to poorer quality of care without the healthcare professionals even realizing it. Biases against the elderly can begin during training for students interested in healthcare. Their teachers and superiors might display negative attitudes towards the elderly, treating them as "frustrating, uninteresting, and less rewarding" (Ouchida & Lachs, 2015). Students are also more likely to perceive the elderly as irrational, weak, and impossible to truly save. It might not seem as important to a doctor or nurse to save an elderly patient who is closer to death than a younger person with a family to take care of and future ahead of them. Perhaps without even being aware of it, healthcare professionals tend to devalue the lives of older people. These attitudes can easily be passed from student to teacher, creating a cycle of bias against older populations. Despite a growing need for geriatric healthcare professionals, people seeking positions in that field are often looked down upon by their peers. For instance, nurses consider geriatric nurses to be of lower status than others

(Wyman, Shiovitz-Ezra, & Bengel, 2018)). Not all physicians and healthcare professionals feel negatively towards elderly populations, but it is a concerning trend that impacts the health of many.

How do the attitudes of healthcare professionals end up impacting elderly people who need care? The elderly community is very broad, potentially ranging to include people 60 years-old and up, yet some doctors have a tendency to lump them in one group rather than treating them as individuals. Ageism might cause a provider to either over-treat or under-treat a patient (Ouchida & Lachs, 2015). If a provider is dismissive of symptoms of an elderly patient, chalking it up to old age, he is more likely to under-treat the patient. Many primary care providers believe that some things are unavoidable as people age. They believe that symptoms like aches, pains, mental slowness, low energy levels, and depression are more likely caused by age than another underlying disorder. Studies show that both the patients and healthcare professionals minimize pain in old age. Yet, the behavior of the healthcare professional is especially important, because their misconceptions about the elderly people's health reinforces their behavior of downplaying potentially important symptoms. In extreme cases, doctors might be unwilling to help a patient with pain because they feel it is inevitable. Physicians might also be unaware of sexual activity in their elderly patients. Over a quarter of people from 75 years-old to 85 years-old are still sexually active. Yet, physicians are more likely to see decreased libido and erectile dysfunction as problems related to sex in elderly populations and overlook potential connection to sexually transmitted diseases. Therefore, problems related to STDs are more unlikely to be diagnosed. Although the issue of under-treatment is a problem, some healthcare professionals have the opposite problem. They might see factors of old age as potential symptoms of disease, causing them to over-treat the patient. Examples of potential over-treatment includes things such as:

universal antigen screening which could lead to over-diagnosis of benign tumors in the prostate, excessive surgeries, and placement in intensive care towards the end of life despite the patients' wishes otherwise. There is also evidence that excessive testing and prescription medication have led to more harm than good. Questionable medical procedures and tests include "placement of… feeding tubes in patients with advanced dementia, excessive use of diabetes medications…, the use of harmful sedatives…, and the use of antibiotics for bacterial colonization of urine" (Ouchida & Lachs, 2015). Considering each elderly person as an individual rather than as part of an "at-risk" patient could prevent both over-treatment and under-treatment.

CAUSES

Ageism is a complex and multifaceted issue that negatively impacts various aspects of society. How exactly did ageism come about? There are several factors that have contributed to ageism in Western culture. For one, the elderly populations have cultural expectations of roles that they must fill. With current culture focused more on the youth, older populations have fallen in the background. The common media portrayal of elderly people also contributes to people's overall perspectives of them. People's own fears of growing old and dying also contribute to their own personal feelings towards older people. Finally, economic challenges play a role in having people consider older populations more of a burden than an aid.

MEDIA

Globally, culture is becoming increasingly youth-centered. Prominent fashion, activities, music, and media are geared towards youth enjoyment. People of all ages strive to maintain popularity by keeping a youthful appearance, especially women. If one opens a fashion

magazine, they can see the impact it would have on women. Models pose with flawless skin, and anti-ageing creams are advertised so that "you, too, can look like them!" Older women make up a significant part of the global population, and they spend billions of dollars on cosmetics and apparel. Yet, they rarely appear in media promoting these products. One study analyzed the images in several popular fashion magazines such as *Elle*, *Glamour*, and *Cosmo* (Lewis, Medvedev, & Seponski, 2011). They found that females over the age of 40 were used as models between 2.685% and 9.02% of the time. In contrast, younger females were depicted between 65.92% and 90.31% of the time. The remaining models were male. Yet, anywhere from 9% to 23% of the readership was above the age of 50. When older women were shown in the magazines, they were often hidden or photoshopped. Overall, the magazines display a desire for youth and a shunning of older women. Even famous and popular older women are airbrushed in order to maintain their image with a youthful glow. For instance, in 2009, Madonna released heavily photoshopped photos to promote her newest album. Not long after, unedited photos from the shoot were released. Madonna was attacked for promoting an impossible body image, for acting too sexual at her age, and for her unappealing appearance (Gorton & Garde-Hansen, 2013). Although there has been a recent shift towards body-positivity, airbrushing flaws and signs of ageing from people's skin remains a common practice, promoting youthfulness over ageing. As society focuses on being younger, older people become an unwanted "other" group, causing attitudes that lead to ageism.

Negative stereotypes about the elderly are major contributors to ageism. Although some of these stereotypes are passed on through social interactions, the media is a major player in the reinforcement of ageist stereotypes. Similar to magazines, visual media such as television and movies often have an underrepresentation of elderly people compared to their total in the

population. Often, less old characters are created out of fear of making the program old and therefore "uncool" (Loos and Ivan, 2018). This lack of visibility hurts elderly people's ability to connect with others and find importance in society. Generally, groups that have more visibility in media enjoy higher status and power. When elderly people are portrayed in the media, it can show them in a negative light. For instance, elderly people might be portrayed as a financial burden. Additionally, older populations can be described as unintelligent, weak, frail, ugly, lonely, unwilling to embrace change, unhealthy, and poorly dressed (Loos and Ivan, 2018). Recently, trends have embraced more positivity surrounding ageing, and older people have been treated more positively by the media. Yet, this trend likely only applies to middle-aged people under the age of 65. It does not appear that people over the age of 65 are gaining visibility or positivity in media representations. Poor representation can be influenced by all kinds of media. One study showed that elderly people's representations in children's books can begin building stereotypes of older people in children at a young age (Hollis-Sawyer and Cuevas, 2013). The study observed 90 randomly selected children's books and found that older women were represented in about 30% of them. Yet, their depictions were often negative and harmful. They were often described as greedy and ugly "hags." By representing this population negatively to the very young, children could acquire adverse views that they will carry with them throughout their lives. As stereotypes grow about older populations, people behave differently towards them, both implicitly and explicitly, and cultural expectations for older populations develop. People expect them to be background characters, often ignored and isolated, separated from the rest of society. As the media is partially responsible for the development of these stereotypes, they are also partially to blame for the rise of ageism in society.

FEAR OF DEATH AND AGEING

When Robert Butler introduced the concept of ageing, he reasoned it was at least partially due to young people's "distaste for growing old, disease, disability; and fear of powerlessness, uselessness, and death" (Levy & Macdonald, 2016). People are afraid of their own vulnerability, and they sometimes project that fear onto others. Older adults can be a reminder of ageing and death for younger people, causing them to have negative attitudes towards them. One study looked at the potential relationships among ageism and ageing anxiety with contact of ageing adults, positive attitudes towards ageing, and fear of death in young adults (Barnett & Adams, 2018). The study involved 623 undergraduate students between 18 and 30 years-old who volunteered to participate in the study in exchange for course credit. The students took a survey which measured their knowledge of the ageing process, contact level with older people, fear of death, optimism, ageism, and ageing anxiety. The study found that both knowledge about aging and contact with older people were associated with ageism. Fear of death, contact with older people, and optimism were associated with ageing anxiety. Previous studies have found that ageism and ageing anxiety are positively related, so it is likely that there exist relationships of some sort through all of these variables. This study involved a limited amount of people, and it is possible that their scales used to measure any of the factors they attempted to measure were inaccurate in some way. As the survey only included people from a specific school, there is a lack of representation of people from different areas. Yet, various other studies can confirm many of the connections made. Additionally, the relationships can be somewhat reasoned through. As ageism is based a lot on people holding onto stereotypes, exposure to older people can break those stereotypes, decreasing ageist behavior. Additionally, people tend to distrust things that they do not understand. Greater knowledge of the ageism process can help reduce

their fear and anxieties around death by better understanding it. Although this particular study did not find a significant relationship between fear of death and ageism, many other studies have found those relationships.

The Terror Management Theory describes how unconscious fears explain many different phenomena such as ageism. The theory suggests that people's unconscious fear of ageing and death causes their ageist views and behaviors. Their fears are kept at bay by abiding by societal norms. Several studies have indicated that younger people give older people an "outgroup" status in order to avoid contact with what they consider to be representations of an unavoidable yet unwanted future. For instance, one study surveyed 188 student volunteers in four different conditions (Boudjemadi & Gana, 2012). In the first condition, the survey was about 60-year-old people, and the topic of death was not heightened. In the second condition, the survey was about 60-year-old people and the topic of death was heightened. The third and fourth conditions were the same as the first two except that the survey was about 90-year-olds instead of 60-year-olds. The study found that overall, the 90-year-olds were viewed more negatively than the 60-year-olds. Yet, when death was a prominent topic, the 60-year-olds were viewed more negatively. In fact, in that condition, the 90-year-olds were not viewed as significantly more negative than the 60-year-olds. As death was more apparent to the surveyed, the older population was lumped into a larger group that was viewed negatively. Likely, the younger people's unconscious fear of death stirred emotions within them when they were confronted it, which then led to negative attitudes about the older subjects. Similar actions could take place in the real world. In a review on the causes of ageism among young people, the authors concluded that young people often link old age and death and put older adults into an outgroup that they view more negatively (Bodner, 2009). To minimize ageism, they suggest that the link between old and death must be minimized.

To accomplish this goal, it is likely that younger adults must increase exposure to older adults and change their overall concept of old age and death.

POTENTIAL ECONOMIC BURDEN

Finances are not often explained as a cause of ageism, but a common ageist view is that elderly people are a financial burden. Few studies analyze the potential effects of economics on ageism. Researchers in China found that older adults are often perceived as a financial burden (Bai, Lai, & Guo, 2016). People were asked to rate the burden of older people to families and societies on a scale from one to three. The average response was a two, showing some mixed feelings. Feelings were exacerbated in rural areas, where people have less economic means. It can be particularly difficult for people to take care of ageing family members when they do not have the proper financial means, leading to some negative feelings. These feelings can stick with people and even get worse as they age, so that older people feel like a burden themselves, leading to depressive episodes. Another study describes the elderly as a "looming burden" and "financial threat" to younger generations (Oh, Bailenson, Weisz, & Zaki, 2016). Government programs such as Social Security and Medicare work to protect older people. Both programs are funded by the public through taxes. The great number of people retiring are putting the program at risk as not enough people will be paying into the program to keep it successful. Basically, there are more people retiring than the incoming workforce can handle. Current estimates show that the program will not be able to last past the year 2035 unless significant changes are made (Newport, 2019). Although the majority of Americans support the program, they are concerned that it will not be able to support them once they reach retirement age. Some people develop bitter attitudes towards the programs as they believe they are paying into something that they

will never benefit from. Yet, social security is incredibly important for older people. In fact, 57% of retirees describe social security as a major part of their income (Newport, 2019). If it gets to the point where it seems the government will not be able to save Social Security, frustrations against older populations could grow, even though they will be the most at risk.

Assuming anti-ageing research is successful, programs such as Social Security will need to face even bigger changes in order to stay afloat. Social programs are already struggling due to the booming elderly population, and anti-ageing would likely lead to an even more dramatic increase in the elderly population. It is important to consider how this population increase would change society.

PART III: POTENTIAL IMPACT OF ANTI-AGEING RESEARCH

Anti-ageing research has the potential to dramatically change the way we live. It could increase life expectancies by decades or even centuries, at least in principle. Yet, even a 30-year increase would have significant impacts on our lives. For instance, the economy would need to be restructured to make up for a different kind of workforce. How can the retirement age be 65 when that could potentially be the new "middle age?" As older people need to work longer, potentially decades longer, there would be less openings for the incoming workforce. Would this lead to an increased resentment from younger generations? Or perhaps the economy could grow as a new consumer base grows, leading to more economic opportunity for people. As the population structure would change dramatically, people would be more exposed to elderly individuals. Perhaps this could lead to increased exposure and a decreased association of elderly people with death. It is also possible that people could reach a certain age where they no longer fear dying, decreasing the impact of the Terror Management Theory on ageism. As older populations would make up a significant part of the population, it is important to consider what their new role would be as it seems difficult to believe that they would continue to be pushed into the background, especially if they remained healthy. All of the above will be considered in the following chapter.

ECONOMICS

In *The Atlantic*, Gregg Easterbrook writes that life expectancy in America will be 100 years by the end of the century (2014). Easterbrook writes of how Japan's economic efficiency has decreased over recent years. Unfortunately, much of this seems to be due to their growing older population. Japan's median age is 45-years-old, and it is likely to continue to increase. Not

only are people living longer, but fewer people are having children to replace them in the economy. Japan also has strict immigration laws which prevent youthful people from migrating to the country. Japan's economy was considered very strong not too long ago, but now its national debt is $10 trillion dollars. The elderly population is expensive to take care of – they have health bills and living costs that are difficult to pay for. Currently, the Japanese government takes care of retirement funds, much like Social Security. Although the costs of these programs are high and difficult to pay for, younger people often do not support cutting the programs because they know that the burden of care for elderly relatives will fall on them. As life expectancy in America rises, similar impacts could be seen. The United States is already in tremendous debt, but it could become even worse with a growing elderly population assuming the economy does not shift to take care of them. One study predicts that Medicare and Social Security could contribute between $3.2 and $8.3 trillion dollars to the national debt by 2050 (Olshansky, 2009). If anti-ageing research is successful, costs for Medicare and Social Security might stabilize rather than increase, because the health of older people will be improved and they will be able to work longer to support themselves rather than relying on the government. Perhaps Social Security could be restructured so that only people disabled or above 80-years-old can collect it, effectively shifting the retirement age. This impact would rely on the ability of anti-ageing to increase healthspan along with lifespan. If people require continuous and significant medical help in order to extend their life, the negative consequences could be even worse. If an aging population contributes heavily to national debt, people's view of older people as an economic burden would only increase, contributing to ageism.

Assuming that people could increase healthspan and lifespan, the retirement age would likely shift. People would be able to handle working for longer time periods. This causes

potential problems for younger people attempting to enter the workforce. There could be fewer positions available for people looking for jobs as they have already been taken by people who have been there for years. Even if the economy grows and more job opportunities become available, higher-level positions are going to be harder to come by. CEOs, political leaders, and even management positions would likely go to people who have decades of experience. With an increase in the retirement age, people would hold onto these positions longer, meaning that there would be fewer opportunities for people to advance. Some of this is already seen in politics. Politics is currently dominated by older people. The average age of a Congressional representative is 57 years-old, and the average age of a Senator is 62-years-old (Easterbrook, 2014). The two current Presidential candidates, Donald Trump and Joe Biden, are 73-years-old and 77-years-old respectively. Perhaps in some ways this could be good. Life expectancy for men in the United States is currently 76-years-old, so both presidential candidates would be over the life expectancy age by the end of their presidency. In politics in particular, older people are more likely to cling to tradition rather than innovation. Older individuals in positions of power have lots of experience and knowledge for them to be successful. Yet, there is also potential for them to be unwilling to embrace the innovation and change that comes more often with younger leadership, limiting industrial growth. Additionally, if young people see that their opportunities are being limited, they are likely to grow more bitter towards older populations. People would have to drastically change their mindsets about advancements by increasing their patience and finding life satisfaction outside of work in order to avoid increasing ageist views.

The current economy would not be able to handle a significantly increased elderly population. The United States could see a damaged economy similar to Japan if changes are not made. In order to prevent devastating effects on the economy, it would have to evolve into

something different, taking advantage of its new assets while still providing space for new people. An article in The Week considered various economic changes that would result from a significantly increased lifespan (Nicholas Warino, 2014). Some economic impacts would be reliant on the success of anti-ageing. For instance, anti-ageing research would have to successfully prevent chronic diseases to benefit the economy. Chronic diseases make up much of public spending on healthcare, so reduction of this spending by preventing these diseases would open up money to be spent on other things while limiting debt. As people are able to work longer, there will be a greater increase in workforce. As previously discussed, this could potentially hurt workers' ability from gaining employment. Yet, competition between applicants could also benefit the economy through increased productivity. It would be important to monitor wages. Hopefully, they would increase along with increased productivity. The government might have to take more of a stand on wages for this idea to be successful. People would also need to drastically change personal financial plans. Perhaps a society can be imagined where not everyone works consistently. If the economy is not able to find places for everyone to work, people could save money to start work later or have a longer retirement. Within this new "free" time, people could travel more, spend more time with family, and try new hobbies. Life would look drastically different than it does now. Although it might be challenging for some to have periods without work, it could also lead people to have greater experiences, resulting in increased happiness. Assuming that the government successfully manages the changes of a growing population, people could have increased life opportunities, limiting an increase in ageism due to limited economic opportunities. In a world that manages to successfully handle the economic challenges of an increased older population, it would be difficult to see how people could have

increased bitterness and ageist views towards the elderly. Yet, that success would be reliant on the government's ability to act and make drastic economic changes before it is too late.

FEAR OF DEATH

The population is already shifting to be comprised more of elderly people. If anti-ageing research managed to significantly increase the lifespan, there would be a much greater proportion of the population past the age of 65. With the increased lifespan, it would be interesting to see how birth rates change. Perhaps people would want to have more children because they would live longer to raise them. Yet, it seems more likely the birth rate would decrease. People would need to save more money for themselves rather than spending it on children as they would likely need to save more for living life while not working, whether that be in a retirement stage or a pre-career life stage. Data can already be extrapolated from places like Japan, where people are living longer and having less children. Having less children would only cause an even greater proportion of the population to be older. There are many potential impacts of this consequence of an extended lifespan. One effect would be that younger people would come into contact with significantly more elderly people. As discussed in Part II, increased contact with older people can destroy the current link that many young people have between older people and death, which leads to ageist behavior. The contact theory helps support this belief. It states that increased contact with outgroups can reduce prejudice against them. Studies have supported the idea that the contact theory is true between younger and older generations. In one such study, researchers examined the relationships between young people's contact with older people, their age anxiety, and their behavior towards the elderly (Bousfield & Hutchison, 2010). 55 university students were included in the study, ranging from 16 to 25 years of age. A survey was used to analyze the

students' quality of contact with elderly people, their anxiety towards elderly people, their anxiety towards ageing, their attitudes towards elderly people, and their behavior towards elderly people. Increased quality of contact was found to be associated with more positive beliefs and attitudes. Frequency of contact, however, was not related to behaviors or attitudes towards the elderly. Other studies have similar findings, with some that only measured frequency of contact with the elderly not finding significant relationships to support the contact theory. Therefore, even though contact would be increased in a society with a significantly increased lifespan, the contact must be meaningful in order to have an impact on ageist views. In this new society, meaningful contact could be with family members, mentors, or even strong societal figures. There is no way to definitively say that an increase in the elderly population would lead to a decrease in ageism through the contact theory. Yet, there is a much greater possibility of a society that would value relationships with older people if the older people made up more active roles in society, as they likely would in a society that they dominated by numbers.

Contact theory likely works by destroying people's stereotypical views of the elderly. As they interact with older people, they realize their perceptions are wrong. Essentially, they are gaining knowledge that helps them reduce their often ignorant views. As anti-ageing research becomes more widespread, people will have greater access to information about ageing. So much is currently unknown about the ageing process, even to people that study it. The general public has even less knowledge about ageing. Yet, if anti-ageing research was successfully implemented across society, people would likely have a greater base knowledge of ageing. For instance, if people gain the ability to extend lifespan by impeding the shortening of telomeres, many people will then understand that telomeres and ageing have a relationship. The same can be said about any of the other theories about ageing, although some might be more complex.

Increased knowledge of ageing would impact people's views of ageing itself, likely reducing ageing anxiety. As ageing anxiety is related to ageism, a reduction in ageing anxiety could also mean a reduction in ageism. In fact, studies that research increased ageing knowledge have shown that people with more knowledge have less anxiety towards ageing and less ageist attitudes. For example, one study examined the relationship between ageing knowledge and ageist behavior (Stahl & Metzger, 2013). 649 undergraduate students were involved in the study. The study found that increased knowledge of ageing and vulnerability to disease led to a decrease in ageism. People are less likely to fear things that they understand, as they recognize its threat. People who understand the mechanisms behind ageing and disease are less likely to associate those things with older people. It cannot be said that people would gain knowledge about ageing with an increase in lifespan. Yet, there would likely be significantly more knowledge to receive, as it would require more knowledge than we currently have for anti-ageing to become successful. People in this hypothetical society could learn about ageing from school, from their own research, or from their older family members who have gone through anti-ageing treatments. Although it would take some personal motivation for people to increase their knowledge, anti-ageing research would give people an increased opportunity to be more informed about the ageing process, reducing age anxiety and ageism in the process.

With a dramatic increase in lifespan, it would be interesting to see if people have the same feelings towards death. Studies on the relationship between death anxiety and ageing surprisingly indicate that death anxiety decreases as people get older, despite the fact that older people are closer to death. An extensive study estimated fear of death at various ages (Gesser, Wong, & Reker, 1988). The study gathered 50 people for three different age groups: the young, the middle-aged, and the elderly. The study describes three types of death acceptances. The first

is Approach-Oriented Death Acceptance, which describes the belied in an eternal existence or happy afterlife after death. People are more likely to happily accept death when they have this kind of acceptance. Escape-Oriented Death Acceptance describes the view that death is an escape from life's pain and suffering. Although the view is not particularly positive, people with Escape-Oriented Death Acceptance feel more welcoming towards death. Finally, there are Neutral Death Acceptors. They believe that death is unavoidable and inevitable. They do not fear or look forward to death, but rather feel at peace with it. The study measured the participants' acceptance levels as well as their fear of death and dying. The study found that the elderly tended to be less afraid of death than both the young and the middle-aged. The middle-aged tended to fear death more than the youthful. These statistics make sense as younger people tend to feel more invisible. Elderly people were significantly more likely to feel acceptance of death through the Approach method, the Escape method, and the Neutral method than the young and middle-aged groups. Elderly people learn to accept death for different reasons. For some, religion and spirituality gives them things to look forward to after death. For others, the end of life is filled with pain, leading them to look forward to death as a way to get rid of their pain. Finally, some people learn to accept death because they feel fulfilled, and there is nothing they believe they need to accomplish anymore.

If life expectancy increases for many, people are not likely to gain earlier acceptance of death through Approach-Oriented Death Acceptance or Escape-Oriented Death Acceptance. People's religious beliefs will likely not dramatically alter with an increase in life expectancy. Older people's tendency to look forward to an afterlife will likely shift to a later period in their life when they are closer to death. Additionally, Escape-Oriented Death Acceptance could decrease as people avoid the majority of chronic illnesses and pain associated with age as they

become less prevalent and more manageable. Yet, it is reasonable to assume that Neutral Death Acceptance could become more prevalent. As people live longer lives, they will accomplish more, leading them to feel more fulfilled. People will have more opportunities to do things that they dream about. They will have time to learn new hobbies, spend time with family, and travel the world, assuming they have the financial means to do so. Some people fear death because they fear loss. Yet, once people reach a point of fulfilment, they no longer feel as attached to things that they were once attached to. In a world where people live to be over a hundred years old, people might start feeling more accepting of death at a younger age. For younger people, they have less to fear as medicine would be powerful enough to prevent them a painful death due to a chronic illness. For older people, they would have ample time to live the life they wanted to live. Increased acceptance of death would lead to a decreased fear of death, and therefore decreased ageism due to associations between older people and dying. We cannot be certain that people would feel more accepting of death given that they have more time. Some people will never likely never feel fully accomplished even if they were given infinite time. Yet, as elderly people already die feeling fulfilled, it seems likely that an increase in lifespan would allow more people to feel the same way at a relatively younger age, ultimately decreasing ageism in society.

CULTURAL IMPACT AND REPRESENTATION

As elderly people become a larger part of the population, it will be nearly impossible to force them out as an "outgroup." Society will once again have to build roles for the elderly to take on. In the past, elderly people were considered to be an important part of society, filled with knowledge and wisdom. Now, people can rely on other sources for knowledge such as widespread education, books, and online sources. Yet, as the elderly population grows, perhaps

the elderly could once again take on the role of being a pillar of wisdom and knowledge in society. They would be able to share decades of experience with their community. This communication could happen through various settings. For instance, an elderly person might have a leadership position that would allow them to share advice. They might take on roles as teachers and mentors. As the elderly become healthier, people are likely to be more willing to accept their advice, knowing it is not tampered by mental slowness or dementia. Having more influential roles in society would likely change people's perspectives of the elderly in a positive way. Additionally, the elderly population will likely take up a larger proportion of spaces in the media. It will be hard to ignore such a large and important part of society. Older people would gain more representation as advertisers would recognize the need for older people to connect to ads. Television and movies would create more elderly characters to target the interest of a growing elderly population. Older people would then show up in magazines, commercials, movies, and television. With increased representation, stereotypes about elderly people could change, creating different, likely more positive, views of the elderly among the general public. As stereotypes dissipate with increased visibility of older people, ageism would decrease.

REFRAMING AGEING IDEAS

People often lump together very large groups of people. For instance, ageism can cause a person to view a 60-year-old in a similar way to a 90-year-old, despite a thirty-year age difference. People view these very large groups as homogenous, but they are far from it. If current ideas about ageing were kept and the lifespan was extended, people would be lumping even larger groups of people together who harbor even greater differences, causing acts of ageism to potentially increase. One could also imagine that people might lump together a

similarly sized group of people, but shift the ages towards the newer, extended lifespan. For example, if the new lifespan was 150 years old, people might view a 120-year-old and 150-year-old the same. Yet, increasing the lifespan might also change people's ideas of ageing completely. Studies indicate that ideas of ageing needs to be reframed (Robbins, 2015). People do not meet ageing milestones at the same pace as others. Rather than attribute someone's health to their age, it should be attributed to their actions, environment, and predispositions. A healthy and fit 65 year-old looks very differently from a deteriorating 65 year-old, and they likely had very different lives. This difference in health would only grow if not everyone was able to access anti-ageing care. A person with the new medical treatment would likely look extremely different from a person lacking it. Perhaps this difference could cause people to treat older people more as individuals because the differences between them are too great to lump them all in one group. If anti-ageing treatments are accessible by anyone who desires it, younger people might finally be able to differentiate groups based on their interests and traits rather than their closeness to death due to the overall increase in health in society.

CONCLUSION

Anti-ageing research must come a long way before treatment could be implemented in a widespread way. There are many ways that researchers are currently looking at extending life. The use of already-existing medication like Metformin and Rapamycin shows promise. Current disorders like Laron Syndrome show how certain pathways might be key to improving the lifespan. Telomeres association with ageing leads one to believe that finding a way to pause telomere shortening could significantly extend life. The use of stem cells could treat and even prevent chronic disease. People could potentially control some of their own health through nutritional choices such as caloric restriction given more solid evidence is gained showing that the strategy is effective in improving health in humans. Yet, all of these ideas are still mostly in the beginning of their journey towards fulfillment. Although significant animal testing has been done, people would need to undergo years of clinical trials before any kind of drug or vaccine would be available to the public. Even before clinical trials, there is the need to build evidence supporting the ideas behind the potential vaccine or drug, more evidence than any of the theories have so far.

Although anti-ageing research is far from becoming prominent in society, it is important to consider such research critically as its implications are far-reaching. A significant expansion in the lifespan would impact the economy, sustainability efforts, overpopulation issues, environmental problems, and societal norms and cultural values. For instance, ageism would likely be impacted by an extended lifespan. It is impossible to tell exactly how ageism would change as much of it would depend on how society reacts to an extended lifespan. Would the economy properly adapt? Would the elderly gain a more prominent role in society thanks to their health? Would they take up too many powerful positions in society, alienating younger groups?

In many ways, ageism could decrease with an increased lifespan. Older people would likely receive improved visibility, representation, and respect as they gain more positions in society, eliminating previous stereotypes. Additionally, a weakening fear of death and a healthier older population could eliminate the association between older people and dying that is common among younger people. The loss of this association could also decrease ageism. These effects depend deeply on the reaction of society to this great change. People must be successful in producing responses to problems before they become so much of an issue that society turns against older populations more so than they already do.

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BIOGRAPHY

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